

## Quad SPST CMOS Analog Switches

### Features

- Low On-Resistance: 50  $\Omega$
- Low Leakage: 80 pA
- Low Power Consumption: 22 nW
- Fast Switching Action— $t_{ON}$ : 120 ns
- Low Charge Injection
- DG211/DG212 Upgrades
- TTL/CMOS Logic Compatible

### Benefits

- Low Signal Errors and Distortion
- Reduced Power Supply Requirements
- Faster Throughput
- Improved Reliability
- Reduced Pedestal Errors
- Simple Interfacing

### Applications

- Audio Switching
- Battery Powered Systems
- Data Acquisition
- Sample-and-Hold Circuits
- Telecommunication Systems
- Automatic Test Equipment
- Single Supply Circuits
- Hard Disk Drives

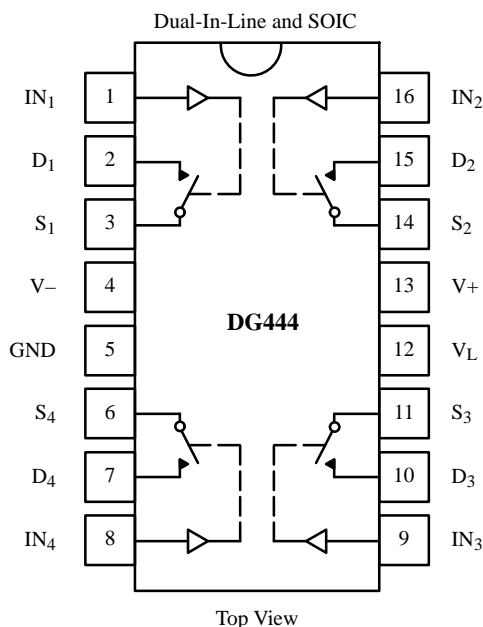
### Description

The DG444/DG445 monolithic quad analog switches are designed to provide high speed, low error switching of analog signals. The DG444 has a normally closed function. The DG445 has a normally open function. Combining low power (22 nW, typ) with high speed ( $t_{ON}$ : 120 ns, typ), the DG444/DG445 are ideally suited for upgrading DG211/212 sockets. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

To achieve high-voltage ratings and superior switching performance, the DG444/DG445 are built on Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks input voltages to the supply levels when off.

### Functional Block Diagram and Pin Configuration



Truth Table

| Logic | DG444 | DG445 |
|-------|-------|-------|
| 0     | ON    | OFF   |
| 1     | OFF   | ON    |

Logic "0"  $\leq$  0.8 V, Logic "1"  $\geq$  2.4 V  
Switches Shown for Logic "0" Input

Ordering Information

| Temp Range    | Package            | Part Number |
|---------------|--------------------|-------------|
| -40°C to 85°C | 16-Pin Plastic DIP | DG444DJ     |
|               |                    | DG445DJ     |
|               | 16-Pin Narrow SOIC | DG444DY     |
|               |                    | DG445DY     |

# DG444/445

## Absolute Maximum Ratings

|   |  |
|---|--|
| V+ to V-  | 44 V   |
| GND to V-   | 25 V   |
| V <sub>L</sub>  | (GND -0.3 V) to (V+) + 0.3 V                               |
| Digital Inputs <sup>a</sup> V <sub>S</sub> , V <sub>D</sub> | (V-) -2 V to (V+) +2 V<br>or 30 mA, whichever occurs first |
| Continuous Current (Any Terminal)                           | 30 mA  |
| Current, S or D (Pulsed 1 ms, 10% duty cycle)               | 100 mA   |
| Storage Temperature   | -65 to 125°C   |

|  |        |
|--|--------|
| Power Dissipation (Package) <sup>b</sup> |        |
| 16-Pin Plastic DIP <sup>c</sup>          | 450 mW |
| 16-Pin Narrow Body SOIC <sup>d</sup>     | 600 mW |

### Notes:

- Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- All leads welded or soldered to PC Board.
- Derate 6 mW/°C above 75°C
- Derate 12 mW/°C above 75°C

## Specifications for Dual Supplies

| Parameter                                   | Symbol              | Test Conditions<br>Unless Otherwise Specified<br>V+ = 15 V, V- = -15 V<br>V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>e</sup> | Temp <sup>a</sup>         | D Suffix<br>-40 to 85°C |                  |                  | Unit |    |     |
|---|---------------------|---|---------------------------|-------------------------|------------------|------------------|------|----|-----|
|   |                     |   |                           | Min <sup>c</sup>        | Typ <sup>b</sup> | Max <sup>c</sup> |      |    |     |
| <b>Analog Switch</b>                        |                     |   |                           |                         |                  |                  |      |    |     |
| Analog Signal Range <sup>d</sup>            | V <sub>ANALOG</sub> |   | Full                      | -15                     |                  | 15               | V    |    |     |
| Drain-Source On-Resistance                  | r <sub>DS(on)</sub> | I <sub>S</sub> = -10 mA, V <sub>D</sub> = ±8.5 V<br>V+ = 13.5 V, V- = -13.5 V   | Room<br>Full              |                         | 50               | 85<br>100        | Ω    |    |     |
| Switch Off Leakage Current                  | I <sub>S(off)</sub> | V+ = 16.5 V, V- = -16.5 V<br>V <sub>D</sub> = ±15.5 V, V <sub>S</sub> = ∓15.5 V   | Room<br>Full              | -0.5<br>-5              | ±0.01            | 0.5<br>5         | nA   |    |     |
|   | I <sub>D(off)</sub> |   | Room<br>Full              | -0.5<br>-5              | ±0.01            | 0.5<br>5         |      |    |     |
| Channel On Leakage Current                  | I <sub>D(on)</sub>  | V+ = 16.5 V, V- = -16.5 V<br>V <sub>S</sub> = V <sub>D</sub> = ±15.5 V  | Room<br>Full              | -0.5<br>-10             | ±0.08            | 0.5<br>10        |      |    |     |
| <b>Digital Control</b>                      |                     |   |                           |                         |                  |                  |      |    |     |
| Input Current V <sub>IN</sub> Low           | I <sub>IL</sub>     | V <sub>IN</sub> under test = 0.8 V<br>All Other = 2.4 V   | Full                      | -500                    | -0.01            | 500              | nA   |    |     |
| Input Current V <sub>IN</sub> High          | I <sub>IH</sub>     | V <sub>IN</sub> under test = 2.4 V<br>All Other = 0.8 V   | Full                      | -500                    | 0.01             | 500              |      |    |     |
| <b>Dynamic Characteristics</b>              |                     |   |                           |                         |                  |                  |      |    |     |
| Turn-On Time                                | t <sub>ON</sub>     | R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = ±10 V, See Figure 2   | Room                      |                         |                  | 120              | 250  | ns |     |
| Turn-Off Time                               | t <sub>OFF</sub>    |   | DG444                     | Room                    |                  |                  | 110  |    | 140 |
|   |                     |   | DG445                     | Room                    |                  |                  | 160  |    | 210 |
| Charge Injection <sup>e</sup>               | Q                   | C <sub>L</sub> = 1 nF, V <sub>S</sub> = 0 V<br>V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω   | Room                      |                         |                  | -1               |      | pC |     |
| Off Isolation <sup>e</sup>                  | OIRR                | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz   | Room                      |                         |                  | 60               |      | dB |     |
| Crosstalk (Channel-to-Channel) <sup>d</sup> | X <sub>TALK</sub>   |   | Room                      |                         |                  | 100              |      |    |     |
| Source Off Capacitance                      | C <sub>S(off)</sub> | f = 1 MHz   | Room                      |                         |                  | 4                |      | pF |     |
| Drain Off Capacitance                       | C <sub>D(off)</sub> |   | Room                      |                         |                  | 4                |      |    |     |
| Channel On Capacitance                      | C <sub>D(on)</sub>  |   | V <sub>ANALOG</sub> = 0 V | Room                    |                  |                  | 16   |    |     |

### Specifications for Dual Supplies (Cont'd)

| Parameter               | Symbol           | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$<br>$V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^e$ | Temp <sup>a</sup> | D Suffix<br>-40 to 85°C |                  |                  | Unit |
|-------------------------|------------------|--|-------------------|-------------------------|------------------|------------------|------|
|                         |                  |  |                   | Min <sup>c</sup>        | Typ <sup>b</sup> | Max <sup>c</sup> |      |
| <b>Power Supplies</b>   |                  |  |                   |                         |                  |                  |      |
| Positive Supply Current | I+               | $V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$<br>$V_{IN} = 0\text{ or }5\text{ V}$  | Room Full         |                         | 0.001            | 1<br>5           | μA   |
| Negative Supply Current | I-               |  | Room Full         | -1<br>-5                | -0.0001          |                  |      |
| Logic Supply Current    | I <sub>L</sub>   |  | Room Full         |                         | 0.001            | 1<br>5           |      |
| Ground Current          | I <sub>GND</sub> |  | Room Full         | -1<br>-5                | -0.001           |                  |      |

### Specifications for Unipolar Supplies

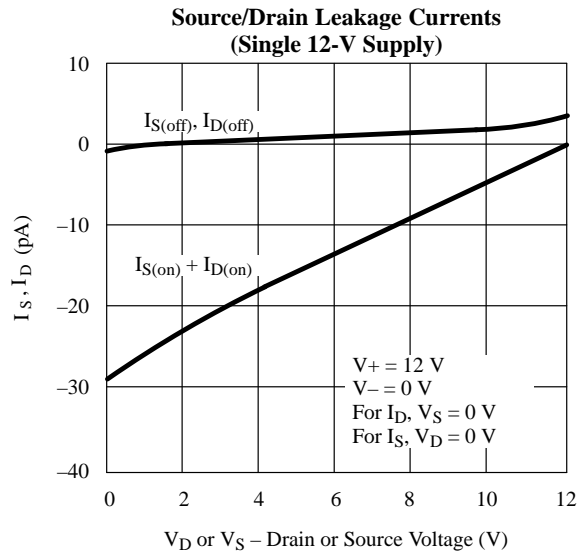
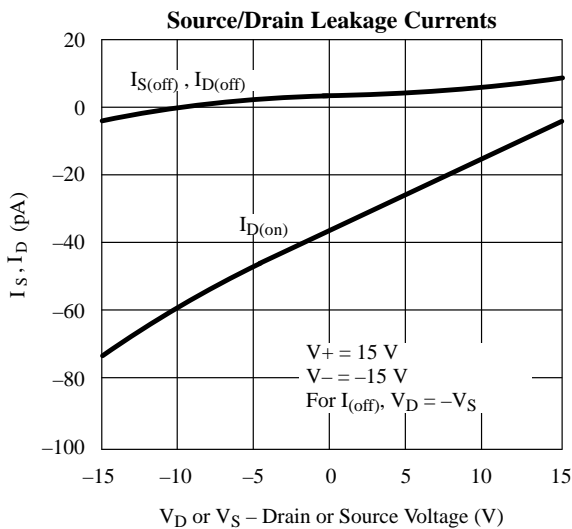
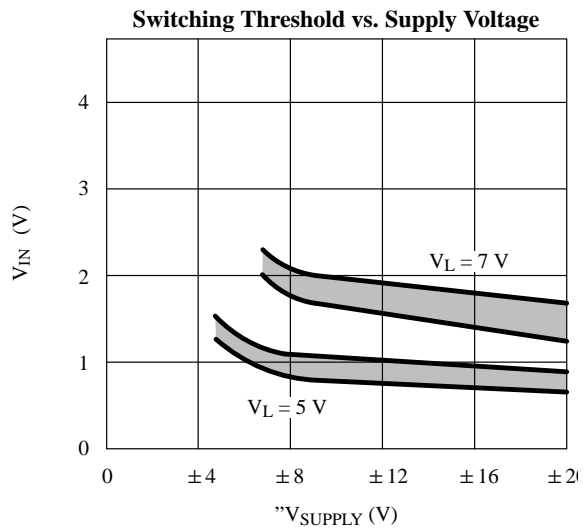
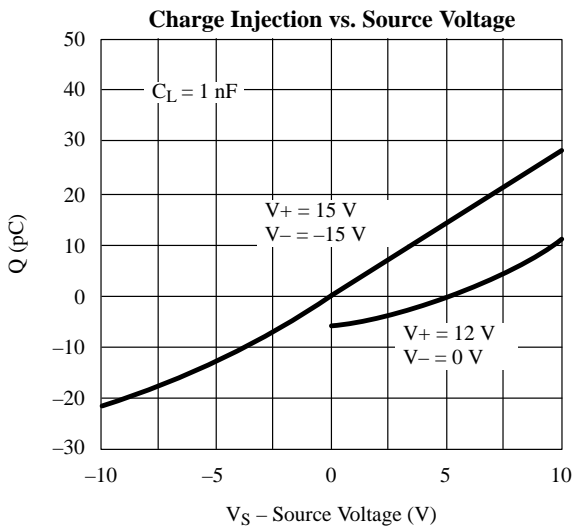
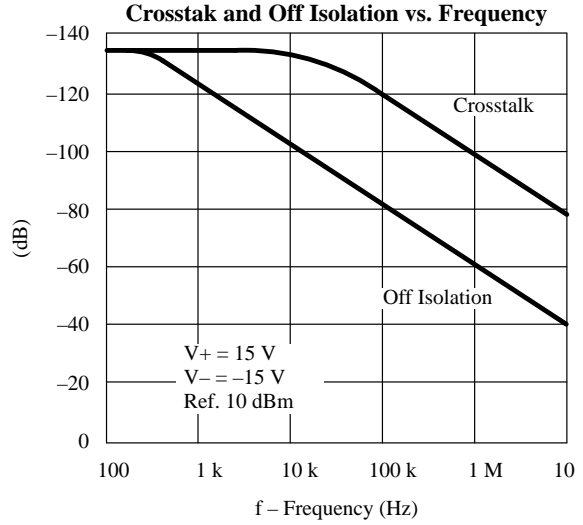
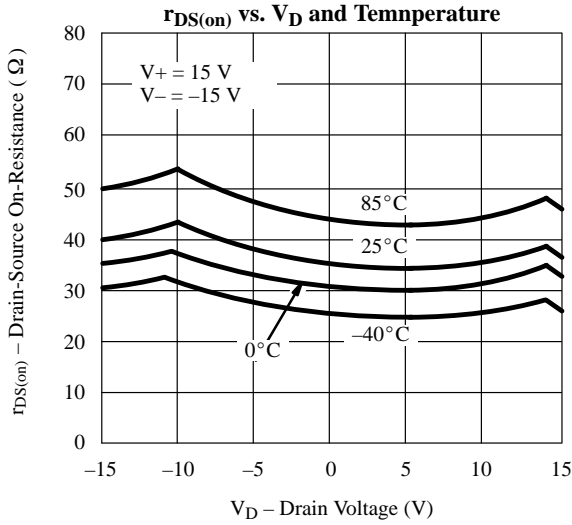
| Parameter                               | Symbol              | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$<br>$V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^e$ | Temp      | D Suffix<br>-40 to 85°C |                  |                  | Unit |
|---|---------------------|--|-----------|-------------------------|------------------|------------------|------|
|   |                     |  |           | Min <sup>c</sup>        | Typ <sup>b</sup> | Max <sup>c</sup> |      |
| <b>Analog Switch</b>                    |                     |  |           |                         |                  |                  |      |
| Analog Signal Range <sup>d</sup>        | V <sub>ANALOG</sub> |  | Full      | 0                       |                  | 12               | V    |
| Drain-Source On-Resistance <sup>d</sup> | r <sub>DS(on)</sub> | $I_S = -10\text{ mA}$ , $V_D = 3\text{ V}$ , $8\text{ V}$<br>$V_+ = 10.8\text{ V}$ , $V_L = 5.25\text{ V}$   | Room Full |                         | 100              | 160<br>200       | Ω    |
| <b>Dynamic Characteristics</b>          |                     |  |           |                         |                  |                  |      |
| Turn-On Time                            | t <sub>ON</sub>     | $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ , $V_S = 8\text{ V}$<br>See Figure 2   | Room      |                         | 300              | 450              | ns   |
| Turn-Off Time                           | t <sub>OFF</sub>    |  | Room      |                         | 60               | 200              |      |
| Charge Injection                        | Q                   | $C_L = 1\text{ nF}$ , $V_{gen} = 6\text{ V}$ , $R_{gen} = 0\text{ }\Omega$   | Room      |                         | 2                |                  | pC   |
| <b>Power Supplies</b>                   |                     |  |           |                         |                  |                  |      |
| Positive Supply Current                 | I+                  | $V_+ = 13.2\text{ V}$ , $V_{IN} = 0\text{ or }5\text{ V}$  | Room Full |                         | 0.001            | 1<br>5           | μA   |
| Negative Supply Current                 | I-                  | $V_{IN} = 0\text{ or }5\text{ V}$  | Room Full | -1<br>-5                | -0.0001          |                  |      |
| Logic Supply Current                    | I <sub>L</sub>      | $V_L = 5.25\text{ V}$ , $V_{IN} = 0\text{ or }5\text{ V}$  | Room Full |                         | 0.001            | 1<br>5           |      |
| Ground Current                          | I <sub>GND</sub>    | $V_{IN} = 0\text{ or }5\text{ V}$  | Room Full | -1<br>-5                | -0.001           |                  |      |

Notes:

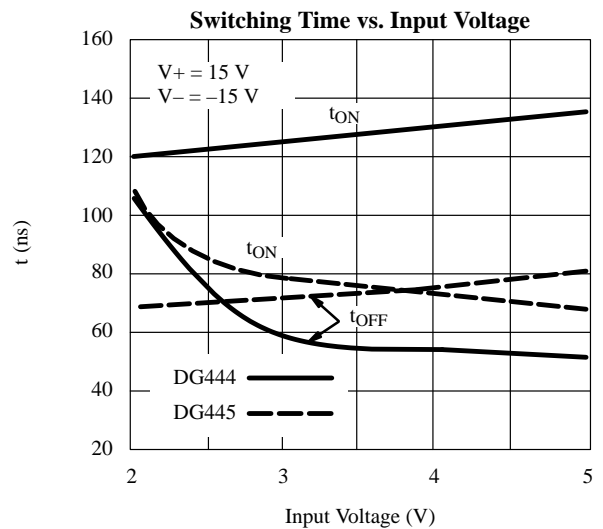
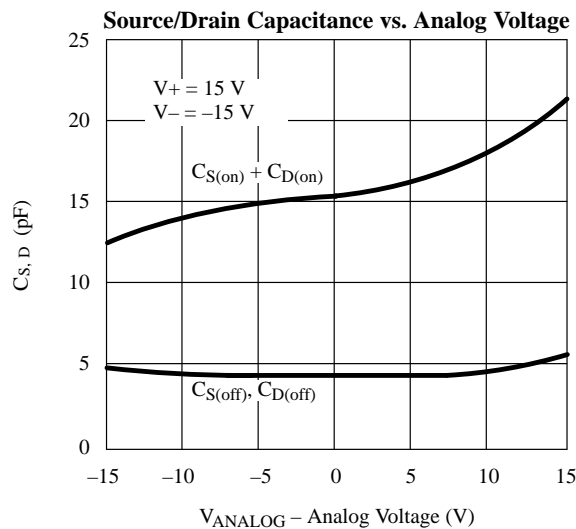
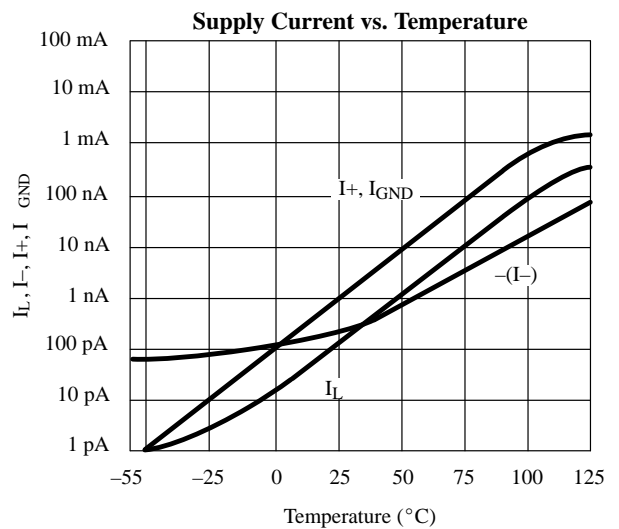
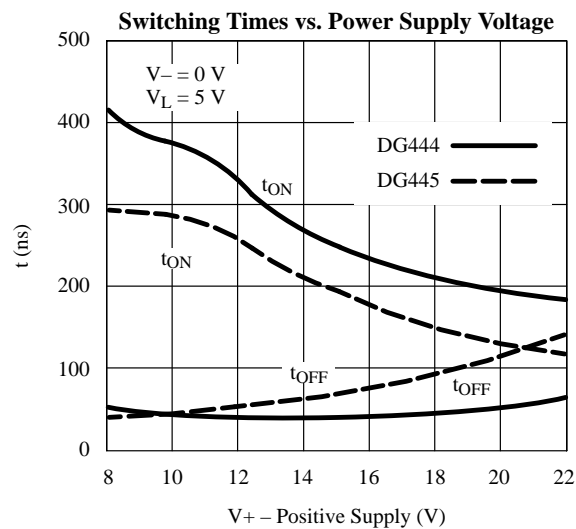
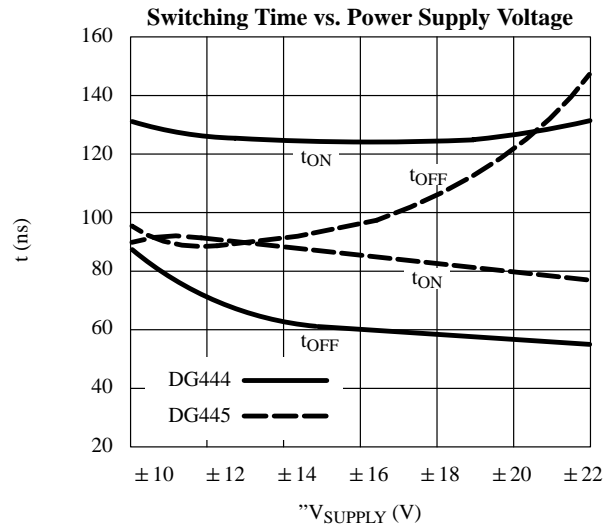
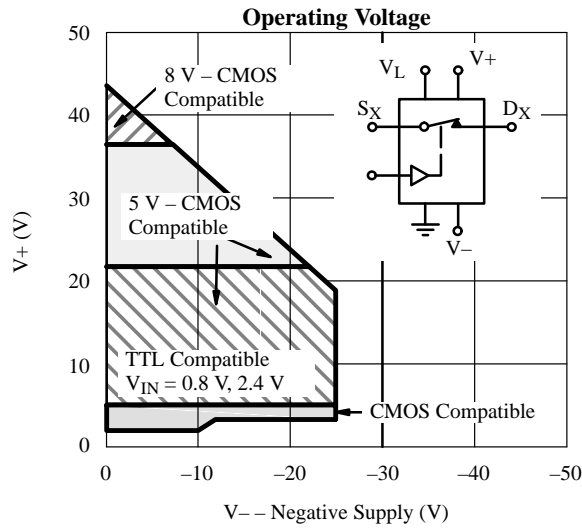
- Room = 25°C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- $V_{IN}$  = input voltage to perform proper function.

## DG444/445

### Typical Characteristics



## Typical Characteristics (Cont'd)



## DG444/445

### Schematic Diagram (Typical Channel)

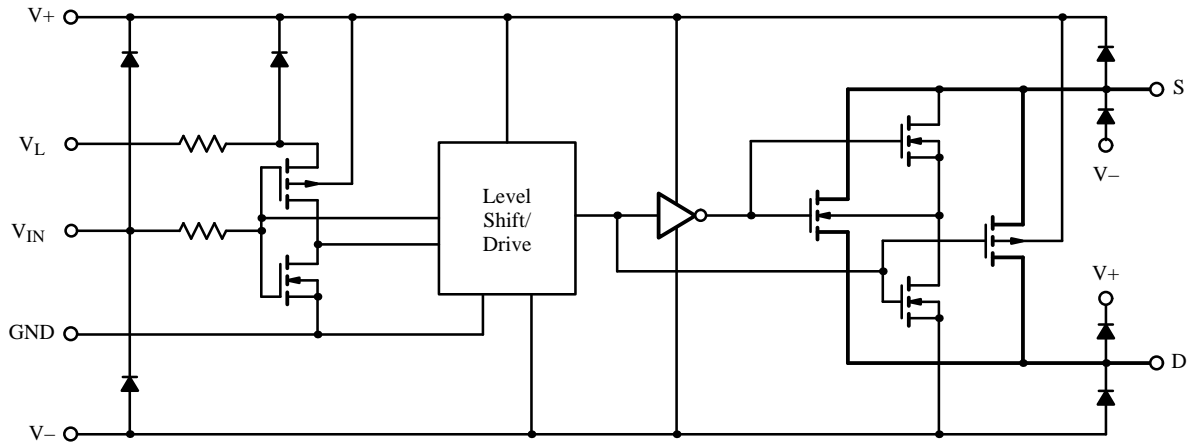
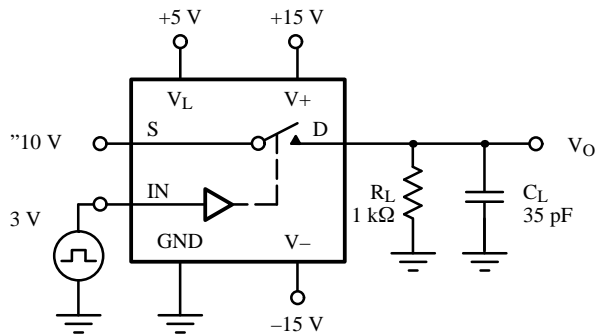
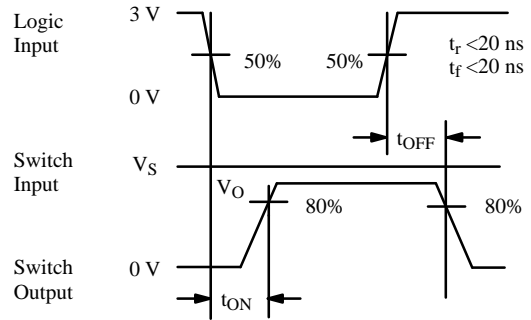


Figure 1.

### Test Circuits



$C_L$  (includes fixture and stray capacitance)



Note: Logic input waveform is inverted for DG445.

Figure 2. Switching Time

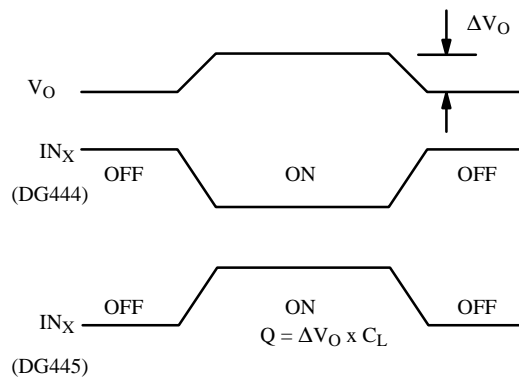
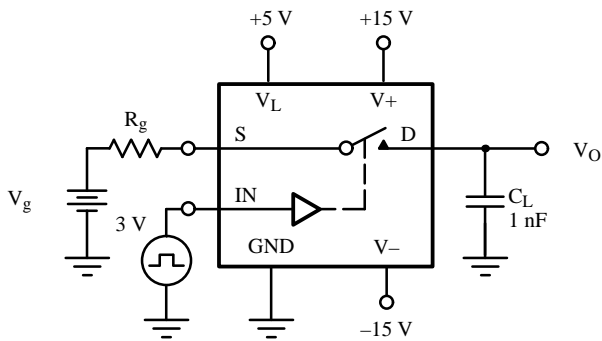
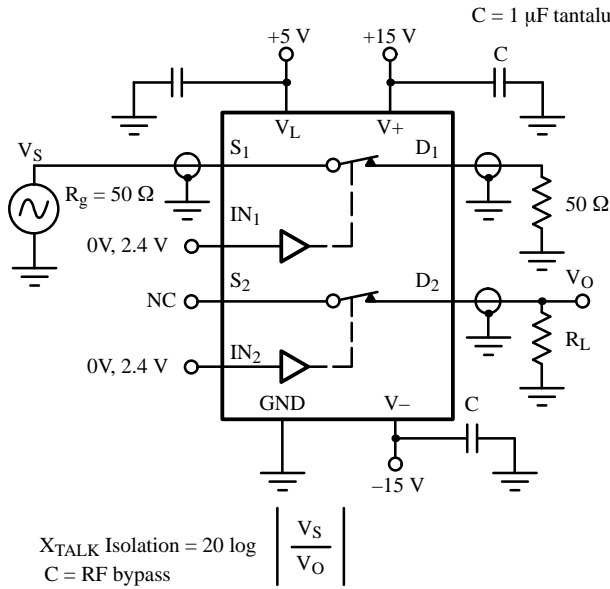
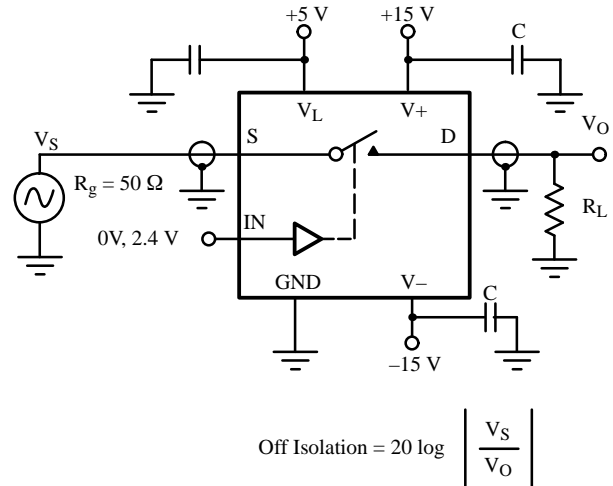


Figure 3. Charge Injection

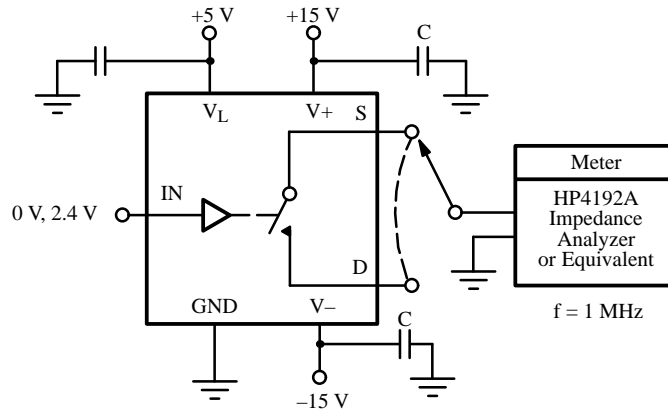
## Test Circuits (Cont'd)



**Figure 4.** Crosstalk

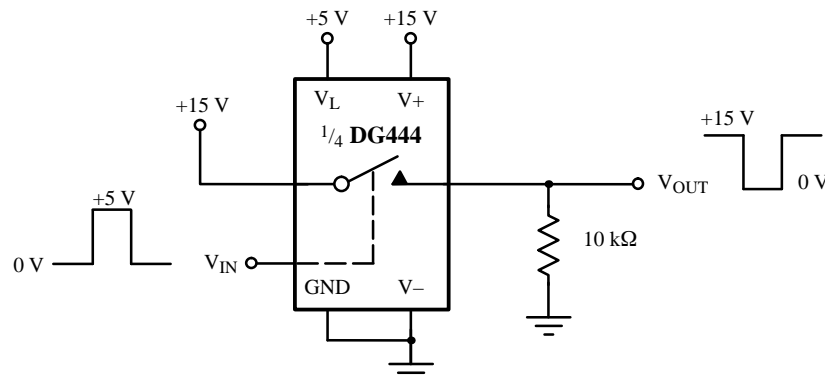


**Figure 5.** Off Isolation



**Figure 6.** Source/Drain Capacitances

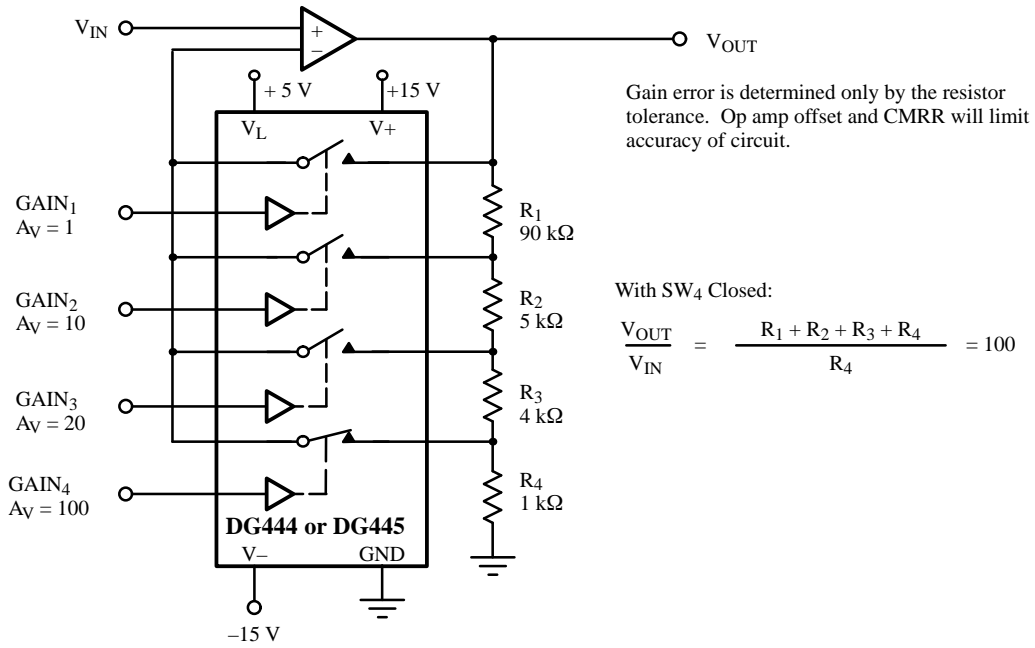
## Applications



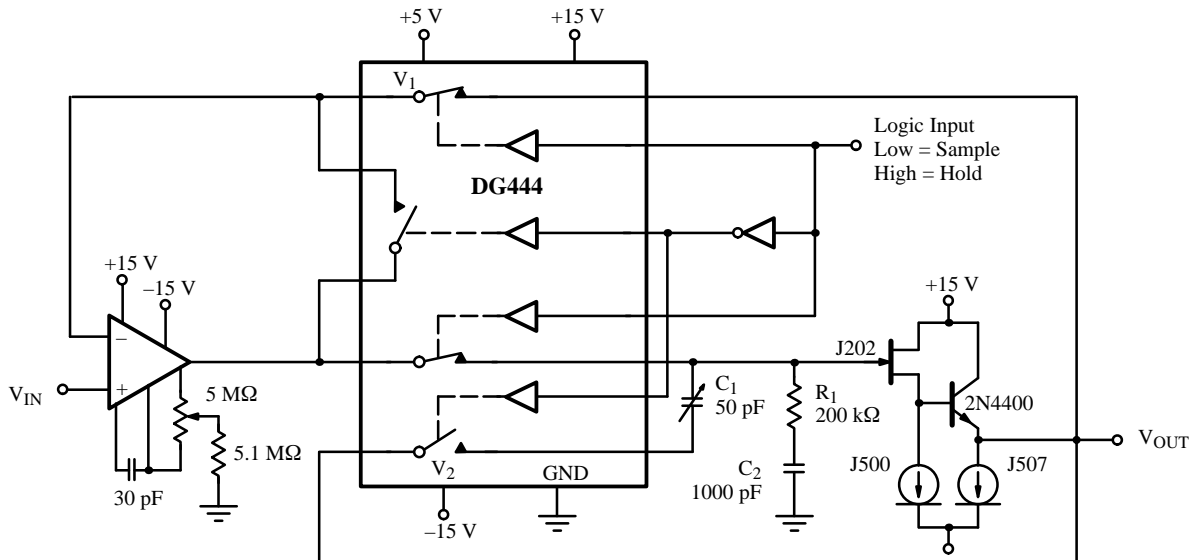
**Figure 7.** Level Shifter

## DG444/445

### Applications (Cont'd)



**Figure 8.** Precision-Weighted Resistor Programmable-Gain Amplifier



**Figure 9.** Precision Sample-and-Hold